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Examining the AI-related factors influencing innovative business development in South Africa

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Abstract

This study examines the critical role of artificial intelligence (AI)-related factors in driving innovative business development in South Africa, a developing economy that faces unique challenges. Using the Technology-Organization-Environment (TOE) framework, this study explores how AI skills, technical infrastructure, and competitive pressures influence organizational innovation. A quantitative research design was employed to collect data through cross-sectional online surveys targeting professionals involved in AI strategies and integration. The findings reveal that while technical infrastructure significantly impacts innovation, a critical skills gap and intense competitive pressure hinder effective AI adoption. This study highlights the urgent need for investments in digital infrastructure, workforce upskilling, and targeted policy interventions to address these barriers. By addressing these factors, South African businesses can leverage AI for sustainable growth and enhance their competitiveness in the global market. This study contributes to the growing body of knowledge on AI adoption in resource-constrained settings and offers actionable insights for policymakers and industry leaders.

Keywords: Artificial intelligence, Competitive pressure, Economic growth, Innovative business development, Technical infrastructure.

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1. Introduction

AI refers to different things to different people, and Tarr [1] describes AI as a computer or machine's ability to portray human-like capabilities that would normally require human intellect. AI presents a new path for innovative business

development, particularly in developing economies, such as South Africa. Innovative business development involves the development of "cash cow and star products" with innovative developments of novel solutions to meet and even create new consumer needs, also known as "disruptive innovations" [2]. A good example of the use of AI in business operations and innovation is the proliferation of AI chatbots used to handle customer interactions, which can reduce labor costs and free up capital that would otherwise be allocated to human resources. These resources can be redirected toward further investment in AI technologies and human capital, focusing on strategic pursuits [3].

Tarr [1] argued that leveraging AI technologies could allow developing countries to catch up and overtake their developed counterparts. Embedding these innovations at the core of their economic and systemic infrastructure would enable them to find a way around traditional industrial practices, where established sectors may resist changing from the conventional systems that led to their success. However, this journey entails challenges such as a lack of skills, inadequate technical infrastructure, and competitive pressures [4]. While studies have examined the benefits of AI integration in innovative business development [2, 3, 5] there is a lack of studies focusing on the South African context. This study focuses on South Africa because of its status as a leading economy in Africa and its increasingly digitalized business environment. However, South Africa faces significant challenges in AI adoption, particularly a critical skills gap, inadequate technical infrastructure, and competitive pressure from advanced markets, which collectively hinder its ability to leverage AI for sustainable growth and economic competitiveness.

The shortage of AI-specific skills limits a country's capacity to develop and deploy AI-driven solutions [6]. Over 40% of organizations in a McKinsey survey cited insufficient AI skills as a barrier to adoption, a challenge likely more pronounced in the South African context [7]. This skill gap restricts internal innovation and reduces competitiveness in the digital economy.

Technical infrastructure disparities between urban and rural areas further impede the adoption of AI. While South Africa boasts some of the region's best infrastructure, businesses in remote and rural areas lack access to high-speed Internet and reliable IT systems [8]. For instance, mobile-only Internet connections in rural regions often lack the capacity for AI applications [9]. These gaps constrain the widespread adoption of AI in critical sectors, such as healthcare, limiting broader economic growth and social development [10].

Finally, competitive pressure from multinational corporations with advanced AI capabilities exacerbates the challenges faced by local enterprises. Limited government support and financial constraints pressure South African firms to innovate in a cost-effective manner or risk losing market share [11, 12]. For example, while global financial institutions leverage AI for personalized banking and fraud detection, South African banks struggle to compete because of resource constraints [13]. This competitive disadvantage risks deepening economic disparities and stalling a nation's development goals.

This study, grounded in the Technology-Organization-Environment (TOE) framework, offers critical insights for businesses, policymakers, academics, and the public in South Africa [14]. By applying this framework, this study explores how these factors shape AI adoption and their impact on fostering business innovation in South Africa. Empirically, this study addresses a gap in the literature by examining AI adoption in a developing economic context, contributing to the academic discourse on AI and business innovation. It extends the TOE framework by providing insights into the barriers and enablers of AI adoption in South Africa, thereby offering a foundation for future studies on technology adoption and innovation [15].

1.1. Underpinning Theory

Popular theories such as the theory of planned behavior (TPB), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technology Acceptance Model (TAM) are not included in this study because they primarily focus on individual decision-making processes [16, 17].

The technological context, comprising existing and emerging technologies within and outside the organization, is pivotal in influencing AI adoption [18]. AI's compatibility with existing systems, its complexity, and the perceived relative advantage it offers, such as enhanced data processing or customer insights, weigh heavily in the decision-making process [19]. The organizational context encompasses internal factors such as company size, executive support, and available resources [20]. These factors dictate an organization's capacity to adopt and effectively utilize AI technologies. External factors that make up the environmental context include industry dynamics and market forces, which exert pressure on firms to use AI [21]. IT startups in South Africa might be under considerable pressure to use AI, both from domestic rivals and from the standards set by international tech giants. These demands, along with the necessity to supply the market with innovative and technologically advanced services, may spur a more aggressive AI adoption strategy [12].

2. Literature Review

2.1. AI in Business

AI is a field of computer science concerned with building computers that can carry out operations that normally require human intelligence [22]. These jobs might involve translating languages, finding patterns in data, recognizing voice, and making decisions. AI uses machine learning models and algorithms to enable computers to learn from data, adapt to new inputs, and perform complex calculations [23-25]. The core of AI is its capacity to handle massive amounts of data at extremely high speeds. This allows AI to provide insights and automations that were previously impossible, thereby revolutionizing the entire industry.

Soni et al. [26] assert that AI is transforming business practices through its significant impact on consumer interactions, decision-making procedures, operational efficiencies, and innovation strategies. Wamba-Taguimdje et al. [27] demonstrated that AI adoption significantly increases operational efficiency by automating repetitive and routine processes.

For example, AI-driven robotic process automation (RPA) makes it possible to automate administrative duties, such as processing invoices and data entry, which reduces human error and expedites turnaround times. AI algorithms are extensively used in the banking industry to automate loan approval processes [28].

Predictive analytics is a key component of AI, helping businesses predict future trends and customer behavior, and identify possible business risks with a higher degree of accuracy [10]. For example, Gochhait et al. [29] expound on how retail behemoths such as Amazon use AI to examine past purchases and browsing patterns of their customers to forecast future purchasing patterns and adjust inventories accordingly.

Ali [30] provided a further example of how AI-powered chatbots and virtual assistants offer individualized customer care by responding to questions and making suggestions around the clock. Starbucks' mobile app uses AI to evaluate user preferences and past purchases in order to provide tailored drink recommendations and rewards.

The potential for revolutionary change and expansion in the corporate landscape is becoming clearer as firms investigate and integrate AI, signaling the beginning of a new era of intelligence-driven, innovative business development.

2.2. Innovative Business Development in the Digital Age

The increasing pace of technological change, evolving consumer preferences, and rising market competition have made innovative business development a critical strategy for sustaining growth and competitiveness in today's global economy [31]. Innovation spans incremental advancements to disruptive models that reshape industries and establish new market norms [32].

AI technologies have revolutionized business models through their unmatched efficiency in recognizing patterns, analyzing large datasets, and automating complex tasks [23]. AI has become a transformative force, enabling businesses to enhance customer engagement, optimize operations, and unlock new market opportunities.

Models such as Open Innovation, Disruptive Innovation, and the Lean Startup Model provide frameworks for navigating technological complexities and market shifts [33, 34]. When paired with AI, these frameworks enable organizations to analyze vast datasets, automate routine tasks, and deliver personalized customer experiences, thereby driving both innovation and differentiation [35].

South Africa presents a dynamic environment for innovation, underpinned by its technological and entrepreneurial culture [36, 37]. Businesses are increasingly adopting models such as Open Innovation and Disruptive Innovation to overcome challenges related to infrastructure and economic inequality [38, 39]. AI plays a pivotal role in this transformation, with applications in agriculture, for example, assisting in optimizing crop yields, where AI enhances financial inclusion through personalized banking and fraud detection [37, 40].

Government initiatives such as the Technology Innovation Agency and the National System of Innovation support entrepreneurship and digital skill development, fostering an ecosystem for sustained growth [41, 42]. These efforts are complemented by private sector investments in infrastructure and partnerships, aimed at driving innovation across diverse sectors.

Despite progress, challenges remain, particularly in rural areas where capital shortages and infrastructure gaps hinder innovation [43]. However, these obstacles can also present opportunities involving the rise of renewable energy solutions in response to grid reliability issues, fortuitously aligning with global sustainability trends [44].

South Africa's innovative businesses, such as Siyavula, in education and various fintech initiatives, are increasingly gaining international recognition. These enterprises highlight how regional innovations can have a global impact by providing scalable models for addressing challenges in other markets. By leveraging entrepreneurship, creativity, and technology, South Africa demonstrates its potential to lead in innovative business development, driving economic growth and societal advancement [45].

2.3. AI Skills

Sima et al. [46] conducted a systematic review of the trends in automation and digitalization and their impact on the transformation of job roles and employment. They demonstrated that these developments have had an increased impact on economies and led to substantial changes in social policies. The aim of their systematic literature review was to present an overview of the studies conducted to date on the effects of the Fourth Industrial Revolution (4IR) on consumer behavior and the development of human capital. The findings showed that human capital was changing from static education and qualification for a career in one field to one in which continuous learning through the regular acquisition of new skills is necessary. In addition, these new skills must be linked to the development of novel individual skills related to management, risk management, self-management, leadership, communication skills, and knowledge, and retraining in emotional intelligence.

This study supports the hypothesis that individuals from underprivileged social classes and those with lower educational attainment tend to exhibit higher levels of social uneasiness and risk. The study also found that a lack of skills impedes automation in factories, supporting the hypothesis in this regard.

This hypothesis is further supported by a study by Reim et al. [47] designed to examine the implementation of AI and how it can be used to catalyze business model innovation, this study aimed to provide a roadmap for business model innovation by identifying the training and upskilling of the workforce as an important factor in the successful implementation and integration of AI. This supports the hypothesis that a clear impediment to AI adoption is the lack of a skilled workforce. They stated that employees are less likely to trust AI if they do not understand how it operates. Educating the workforce on AI will increase knowledge and skills. Finally, the hypothesis is supported by the recommendation that broad AI training is required to take advantage of AI.

Lee et al. [48] conducted a similar study on emerging technology and business model innovations. This study examines how executives can create an innovative AI-based culture to successfully capitalize on disruptive innovations. The study advocates for the creation of small-scale pilot projects to build AI skills, disseminate knowledge to key figures and the workforce at large, provide broad AI training focused on educating all employees, and develop digitalized training content. This supports the hypothesis that, without taking these steps, an AI-based innovative culture will be difficult to attain, once again reinforcing the fact that AI skills will influence innovative business development.

These studies, conducted by Sima et al. [46], Reim et al. [47] and Lee et al. [48] clearly demonstrate a significant relationship between AI skills and innovative business development. They show that a skilled workforce leads to a more successful integration of AI capabilities, resulting in innovation in business development.

H_1: AI Skills have a positive and significant effect on innovative business development in South Africa.

2.4. Technical Infrastructure

Lee et al. [48] also found in their study on business model innovation is the assertion that technical infrastructure is crucial to the successful adoption of AI in business models and, consequently, innovation. They assert that attempting to adopt AI without the appropriate infrastructure is like 'building a palace on quicksand.' This study also supports the hypothesis that technical infrastructure has a significant impact on the adoption of AI and, consequently, on innovative business development driven by technology.

In Mhlanga [37] study on AI in Industry 4.0 and its impact on poverty, innovation, infrastructure development, and the SDGs examined the important relationship between AI and technical infrastructure. Mhlanga investigated not only how AI drives infrastructure development but also the inverse relationship. Mhlanga contends that investment in infrastructure and innovation is one of the drivers of economic growth. Mhlanga further states that with 4 billion people without access to the Internet, 90% of whom are in developing and emerging economies like South Africa, AI-driven innovation and entrepreneurship, supported by substantial investments in infrastructure, will help bridge the gap while simultaneously advancing sustainable development goals. This study strongly suggests that there is evidence supporting the theory that a positive relationship exists between technical infrastructure and innovative business development driven by emerging technologies such as AI. These studies collectively underscore the significant link between technical infrastructure and the successful deployment of AI for innovative business development.

H_2: Technical Infrastructure has a positive and significant impact on innovative business development.

2.5. Competitive Pressure

Distanont [49] focused on examining the innovative factors that lead to a competitive advantage in the frozen food industry, and competitive pressures were identified as a key driving force. The findings showed that external factors at the macro- and micro-levels led to the need for entrepreneurs, especially at the SME level, to be ready to adapt. The study finds that competitive pressure is an important factor in the creation of innovations. These findings support the hypothesis that competitive pressure may have a positive and significant impact, forcing businesses to survive.

In a study by Tu and Wu [50], which explored the impact of green innovation on a business's competitive advantage, it was found that external pressures such as stakeholder and policy pressures were significant in driving businesses to innovate. External pressure from stakeholders, particularly competitors, was found to influence businesses' drive to innovate. These findings can also be transposed into AI-related matters, supporting the hypothesis that competitive pressures have a positive and significant influence on innovative business development, such as green innovation and, consequently, AI-driven innovation.

Both studies highlight the positive influence of competitive pressure on innovation, suggesting that these pressures are key drivers for businesses to innovate, including in the realm of AI, to maintain competitiveness and ensure survival.

H_3: Competitive pressures have a significant positive impact on innovative business development.

3. Methodology

3.1. Population and Sample

This study adopts a quantitative research methodology to explore the impact of AI skills, technical infrastructure, and competitive pressure on innovative business development in South Africa. The survey was crafted based on the TOE framework, aiming to ascertain the influence of these independent variables on the successful adoption and utilization of AI technology in innovative business development, the dependent variable. Through quantitative statistical analysis, this study evaluates the extent to which the independent variables contribute to AI-driven business innovation. The findings will not only illuminate the current state of AI adoption in South Africa but also provide an empirical foundation for future research in the field.

To determine the ideal sample size for reliable statistical analysis, power analysis was conducted using G*Power. This analysis identified the number of participants needed to achieve a statistically significant result. Assuming a moderate effect size of 0.15, with a significance level (α) set at 0.05 to minimize the probability of a Type I error, and considering three predictors, the estimated optimal sample size was projected to be 119 participants.

To further solidify the study's statistical validity and address potential data loss, this study targeted a larger sample size of 150 South Africans in Johannesburg, KwaZulu-Natal, Tshwane, and Western Cape, enhancing the generalizability of its findings. Employing the F-test through linear multiple regression analysis, this study quantitatively dissected the relationship between the independent variables and innovative business development, the dependent variable.

3.2. Research Procedure

The survey was structured using a five-point Likert scale, providing participants with a range of options to express their agreement or disagreement with each statement related to the study's focus areas. To ensure the relevance and reliability of the data, a cross-sectional approach was employed, with data collected via online surveys. Participants were purposively selected, focusing on personnel involved in key roles related to innovation, AI integration, and strategy in South African businesses. Their participation was entirely voluntary, with the confidentiality and privacy of the information provided being paramount.

Participants were informed of the risk-free nature of their participation, with reassurance that they could withdraw at any stage without repercussions. Eligibility for the study required participants to be professionals engaged with AI initiatives within their organizations, ensuring that the data reflected insights from those directly involved in technological transformation processes.

The questionnaire explored how AI skills, technical infrastructure, and competitive pressure influenced South African businesses' innovation and AI adoption rates. Following data collection, statistical analysis was conducted to interpret the data effectively. The distribution methods for the survey included various online channels, such as WhatsApp, LinkedIn, and other social media platforms, capitalizing on their broad reach and convenience to facilitate a quick and wide-reaching data collection process. This online distribution strategy was chosen because of its ability to save time and minimize the need for oversight.

3.3. Measurement

The Innovative Business Development construct consisted of six items, such as “We would expect revenue to increase through AI-driven innovation,” adapted and adopted from Füller et al. [51]. It measures the extent to which AI integration enhances organizational innovation, operational efficiency, and market competitiveness. Cronbach's alpha for this construct was 0.852.

The AI Skills construct consisted of five items (e.g., " My company provides resources regarding AI"), adapted from Sassis et al. [52] and Füller et al. [51]. These items measured the organization's access to AI-specific skills, digital literacy, and the adequacy of training in machine learning and data science. The Cronbach's alpha for this construct was 0.774, indicating acceptable reliability.

The Technical Infrastructure variable was assessed using five items (e.g., " Our company has the infrastructure (hardware) to integrate AI capabilities.") adapted from Füller et al. [51], Chen et al. [53] and Chatterjee et al. [19]. The items examined the quality and accessibility of the digital infrastructure, including Internet speed, data storage capabilities, and technological readiness. The Cronbach's alpha for this construct was 0.749, reflecting good internal consistency.

The Competitive Pressures construct comprises five items (e.g., "Our competitors who have implemented AI initiatives have become more competitive"), adapted from Tomar et al. [40], Chatterjee et al. [19] and Chen et al. [53]. This construct measures external competitive forces driving innovation, including pressures from multinational corporations and domestic competitors. Cronbach's alpha for this construct was 0.826, demonstrating strong reliability.

3.4. Data Analysis

The survey data were analyzed using the Statistical Package for Social Sciences (SPSS) version 26, a comprehensive tool for managing and evaluating data [54]. Both descriptive and inferential statistical methods were employed to derive actionable insights. Descriptive statistics, including frequencies and percentages, were summarized, and the dataset's characteristics were presented through tables and figures, making trends and patterns easily interpretable. Inferential statistics evaluate hypotheses at a 95% confidence level, with p-values below 0.05, indicating statistical significance [55].

Pearson’s correlation analysis was used to measure the strength and direction of the linear relationships between variables, with values ranging from -1 (perfect negative correlation) to +1 (perfect positive correlation) [56]. Multiple regression analysis assessed the combined impact of AI skills (X_1), technical infrastructure (X_2), and competitive pressures (X_3) on innovative business development (Y).

This approach enables the study to identify statistically significant relationships and the relative influence of each variable, thus providing practical insights for fostering innovation and addressing AI adoption challenges.

4. Results

4.1. Descriptive Analysis

The study achieved an 87.3% response rate, with 131 completed surveys out of 150 distributed via the aforementioned channels, highlighting strong engagement and relevance to the target population.

Demographic data Table 1 revealed that most respondents were Black African (56.5%), followed by White (20.6%), Indian/Asian (10.7%), and Colored (6.9%). The gender distribution included 61.8% male, 36.6% female, and 1.5% non-binary participants. Mid-career professionals aged 36–45 years (40.5%) and 46–55 years (26.0%) dominated the sample, reflecting significant organizational roles.

Educational qualifications demonstrated a highly skilled cohort, with 32.8% holding postgraduate degrees, 32.1% having master’s degrees, and 25.2% holding bachelor’s degrees. Senior professionals accounted for 50.4% of the sample, followed by mid-level (33.6%), self-employed (13.0%), and entry-level employees (3.1%).

Respondents represented organizations with varying financial capacities, with 47.3% of entities generating over R500 million annually and 16.0% earning R100–R500 million. Industries include Financial Services (19.8%), ICT (7.6%), manufacturing (7.6%), and others, highlighting AI's widespread applicability across sectors.

Diverse demographics and organizational profiles provide a strong foundation for analyzing AI-driven innovation in South African businesses, offering valuable insights across industries, roles, and financial scales.

Table 1.
Summary of Key Demographic Information.

Demographic Profile		Frequency	Percentage (%)
Gender	Male	81	61.8
	Female	48	36.6
	Others	2	1.5
Age	26-35 years old	28	32.6
	36-45 years old	53	40.5
	46-55 years old	34	26
	56 and above	15	11.5
Education Level	Degree	33	25.2
	Masters	42	32.1
	Post-Graduate Degree	43	32.8
Employment Level	Mid-Level	44	33.6
	Senior Level	66	50.4
	Self-Employed	17	13

4.2. Correlation Analysis

Pearson's correlation analysis was conducted to examine the relationships between the dependent variable (Innovative Business Development) and the independent variables (AI Skills, Technical Infrastructure, and Competitive Pressure). Statistical significance was assessed at the 0.01 level (two-tailed), where a p-value less than 0.01 indicates a meaningful correlation. As shown in Table 2, all independent variables showed statistically significant positive correlations with innovative business development. Perceptions of AI skills were significantly related to innovation outcomes, according to the moderate relationship between innovative business development and AI skills ($r = 0.468$, $p < 0.001$). Technical infrastructure and innovative business development also show a moderate positive correlation ($r = 0.490$, $p < 0.001$), indicating a moderate relationship between increased innovation and technological capacity. AI-related innovation is heavily driven by external market factors, as seen by the strongest correlation between innovative business development and competitive pressures ($r = 0.602$, $p < 0.001$).

Pearson's correlation analysis was conducted to examine the relationships among technical infrastructure, AI skills, competitiveness, and innovative business development. Table 2 presents the results. Technical infrastructure is significantly positively correlated with innovative business development ($r = .468$, $p < .01$), indicating that greater technical infrastructure is associated with increased innovative business development. AI skills also showed a significantly positive correlation with innovative business development ($r = .490$, $p < .01$), suggesting that enhanced AI skills contribute to higher levels of innovative business development. Furthermore, competitive pressure demonstrated the strongest positive correlation with innovative business development ($r = .602$, $p < .01$), highlighting its critical role in driving innovative business outcomes.

Table 1.
Pearson's Correlation Analysis.

No.	Variables	1	2	3	4
1	Innovative business development	1			
2	Technical infrastructure	0.468**	1		
3	AI Skills	0.490**	0.596**	1	
4	Competitive Pressures	0.602**	0.529**	0.509**	1

Note: **. Correlation is significant at the 0.01 level (2-tailed).

4.3. Multiple Regression Analysis

Multiple regression analysis was conducted to examine the effects of AI skills, technical infrastructure, and competitive pressure on innovative business development. The overall model was significant, $F(3, N) = 30.124$, $p < .001$, accounting for 40.2% of the variance in innovative business development ($R^2 = .402$).

Among the predictors, competitive pressure emerged as the strongest significant predictor of innovative business development ($\beta = .493$, $t = 5.265$, $p < .001$), indicating that higher levels of competitive pressure are associated with increased innovative business development. Technical infrastructure also significantly predicted innovative business development ($\beta = .196$, $t = 2.220$, $p = .028$), suggesting a positive influence of technical infrastructure on innovative business development.

By contrast, AI skills did not significantly predict innovative business development ($\beta = .119$, $t = 1.322$, $p = .185$), indicating that its contribution to the model was not statistically significant. A summary of the multiple regression analysis results is presented in Table 3.

Table 2.
Summary Results of the Multiple Regression.

Dependant Variable	Predictor Variable	Beta	t	R^2	F	p-value
Innovative Business Development	AI Skills	0.119	1.322	0.402	30.124	0.185
	Technical Infrastructure	0.196	2.220			0.028
	Competitive Pressures	0.493	5.265			0.000

5. Discussion

Based on the Technology-Organization-Environment (TOE) framework, this study investigates the relationship between AI skills, technical infrastructure, and competitive pressures as factors of innovative business development in South Africa.

It has been posited that AI adoption is influenced by a combination of organizational, technological, and environmental factors, each playing a distinct yet interrelated role [16]. AI skills are positioned as a key organizational capability, reflecting the readiness of the workforce to adopt and integrate AI technologies effectively. Technical infrastructure was identified as a critical technological enabler, facilitating the seamless deployment of AI-driven systems. Finally, competitive pressure was highlighted as an environmental force compelling organizations to innovate to remain competitive. The framework's development was informed by an extensive review of the existing literature, which identified these constructs as pivotal to understanding AI adoption dynamics.

The theoretical framework provides a structural perspective for examining these variables. The organizational dimension, represented by AI skills, emphasizes the importance of having a workforce equipped with the necessary skills to effectively utilize AI. According to Anton et al. [43], a business's capacity to incorporate cutting-edge technology is severely constrained by a lack of AI competence. Although AI skills showed a positive correlation with innovative business development, their predictive power was not statistically significant in this sample, which may be due to systemic educational and industrial gaps in South Africa [6]. However, the technological dimension is a strong predictor of innovative business development, as technical infrastructure has a significant positive impact on innovation. One of the most important factors facilitating innovation is the availability of information technology (IT) systems, hardware, and digital infrastructure. This is consistent with Cubric [57], who emphasized the importance of infrastructure in the expansion of AI-driven operations. This study further highlighted the disparity in technological readiness between urban and rural regions, reflecting barriers to adoption [58].

In the environmental context, the backdrop of competitive pressure had the greatest influence on the development of innovative businesses, with a highly significant regression coefficient and the highest correlation with innovation outcomes. As Masroor and Asim [12] suggested, competition paradoxically encourages and hinders the adoption of AI. According to the findings, companies under high market pressure are more likely to innovate and use AI to maintain or improve their competitive edge.

The results highlight the interplay of organizational capabilities, technological infrastructure, and environmental forces, emphasizing the need for an integrated approach to foster innovation.

The study also notes that South Africa's expertise, uneven infrastructure distribution, and fierce competition from global firms can be viewed as major obstacles to AI adoption in the country. These observations are consistent with earlier studies by Schoeman and Seymour [59] which emphasized comparable systemic issues in the South African setting.

5.1. Recommendations

Key findings emphasize the role of competitive pressure as a significant driver of innovation and the importance of external market forces in compelling organizations to adopt AI technologies. Future studies should explore the interplay between competitive pressure and innovation, especially in developing economies where global and local market forces converge. This will deepen our understanding of how external dynamics shape AI adoption and innovative practices.

Furthermore, the nuanced findings on AI skills, showing positive correlations but no significant direct impact, challenge simplistic assumptions about the role of AI skills in innovation. These results suggest that while these skills are necessary, their effectiveness may depend on complementary factors, such as organizational culture, leadership, and resource availability. Emphasis should be placed on understanding the indirect pathways through which AI skills contribute to innovation.

Organizations must prioritize the modernization of technical infrastructure, including upgrading legacy systems, enhancing Internet connectivity, and adopting scalable technologies such as cloud computing and IoT. These investments will enable the seamless integration of AI technologies and improve efficiency and competitiveness. Managers should implement targeted training and upskilling programs to address AI-related skill gaps. Collaboration with academic institutions and the use of online learning platforms can foster a culture of innovation and continuous improvement. Organizations should use competitive dynamics to study the various applications of AI and AI-related strategies implemented by competitors to proactively drive innovation. By investing in R&D, adopting AI-driven solutions, and exploring new business strategies, companies can turn external pressure into opportunities for differentiation and growth.

Policymakers should prioritize investments in digital infrastructure, particularly in underserved regions, to bridge disparities and create an enabling environment for AI adoption. Governments should introduce tax incentives, grants, and subsidies to encourage organizations to invest in AI training and upskilling initiatives. This will help to address systemic skill shortages and ensure that the workforce is prepared for the digital economy. Regulatory reforms should focus on reducing barriers to innovation, promoting fair competition, and supporting SMEs in adopting advanced technology.

5.2. Conclusion, Limitations and Future Research

This study provides critical insights into the factors driving innovative business development in South African organizations that adopt AI technologies. However, several limitations were identified, presenting opportunities for further research. Methodologically, the cross-sectional design restricted the ability to establish causality, capturing only a snapshot of the relationships among AI skills, technical infrastructure, competitive pressure, and innovation outcomes. The reliance on online surveys, while effective for broad reach, may have excluded respondents with limited digital access, thus affecting sample diversity. Additionally, the sample's emphasis on respondents from the researcher's professional network and economically prominent regions like Johannesburg and Western Cape introduced potential biases, limiting the generalizability to less industrialized areas and smaller enterprises. Instrumentation challenges were also noted, particularly in the construct of AI skills, where the lack of a significant direct effect suggests the influence of overlooked mediating or moderating factors such as organizational culture or leadership support.

These limitations highlight the need for future research to adopt longitudinal designs that explore how AI adoption evolves over time, thereby providing a clearer understanding of causality. Expanding the scope to include other developing nations, underrepresented industries, and small-to-medium enterprises would enhance the applicability of the findings across various contexts. Future studies could also investigate mediating factors, such as leadership or employee engagement, and moderating variables, such as industry type or organizational size, to capture the complexity of the relationships influencing innovation. Employing mixed-method approaches, combining quantitative surveys with qualitative interviews or case studies, could provide richer insights, while advanced techniques such as structural equation modeling could unravel complex interdependencies among variables.

Despite these limitations, this study makes significant contributions by highlighting the critical role of competitive pressure as a driver of innovation, the foundational importance of technical infrastructure, and the complex role of AI skills in fostering innovation. These findings emphasize the interplay between organizational readiness, external market dynamics, and technological capabilities, providing a comprehensive understanding of AI-driven innovation in developing economies. These findings serve as a foundation for future studies and interventions, advancing the discourse on innovation in resource-constrained environments, while paving the way for broader applications of AI in fostering economic growth and competitiveness.

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